Neonatal Abstinence Syndrome: Rethinking Our Approach

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Increasing Incidence of the Neonatal Abstinence Syndrome in U.S. Neonatal ICUs

Veeral N. Tolia, M.D., Stephen W. Patrick, M.D., M.P.H.,
Monica M. Bennett, Ph.D., Karna Murthy, M.D., John Sousa, B.S.,
P. Brian Smith, M.D., M.P.H., M.H.S., Reese H. Clark, M.D.,
and Alan R. Spitzer, M.D.

ABSTRACT

BACKGROUND
The incidence of the neonatal abstinence syndrome, a drug-withdrawal syndrome that most commonly occurs after in utero exposure to opioids, is known to have
HEROIN—HYDROCHLORIDE

is pre-eminently adapted for the manufacture of cough elixirs, cough balsams, cough drops, cough lozenges, and cough medicines of any kind. Price in 1 oz. packages, $4.85 per ounce; less in larger quantities. The efficient dose being very small (1-48 to 1-24 gr.), it is

The Cheapest Specific for the Relief of Coughs
(In bronchitis, phthisis, whooping cough, etc., etc.)

WRITE FOR LITERATURE TO
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SELLING AGENTS
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40 Stone Street, NEW YORK
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DOSE

Five days old, 5 drops
Two weeks old, 8 drops
Five years old, 25 drops
Adults, 1 Teaspoonful
Standard Approach

- Medications
- NICU
- Finnegan Scores
- Medication Dosing
- Staff cares for the baby
Length of Stay: Methadone-Exposed Infants

P <.02
Medication Studies

- DTO vs. DTO plus clonidine: 17 days vs. 12 days
- Morphine vs. Phenobarbitone: 8 days vs. 12 days
- Morphine vs. DTO: 30 days vs. 27 days
- DTO vs. DTO plus Phenobarbitone: 79 days vs. 38 days
- Methadone vs. Morphine: 17 days vs. 24 days
FON THE AMERICAN ACADEMY OF PEDIATRICS
neonatal withdrawal signs. Clinicians have used discrete or serial scores to assist with therapeutic decisions. The Lipositz tool, also known as the Neonatal Drug Withdrawal Scoring System, was recommended in the 1980 American Academy of Pediatrics statement “Neonatal Drug Withdrawal,” probably because it is a relatively simple metric with good sensitivity for identifying clinically important withdrawal. The modified Neonatal Abstinence Scoring System (Fig 1, 101) is the preeminent tool used in the United States. 102 This more comprehensive instrument assigns a cumulative score based on the interval observation of 21 items relating to signs of neonatal withdrawal. In a study administration of this scoring system with infants verified not to have been exposed to prenatal opiates by meconium analysis resulted in a stable median score of 2 during each of the first 3 days of life, with 95th percentile scores of 5.5 and 7 on days 1 and 2, respectively. 103 Infants at risk for NAS should be carefully monitored in the hospital for the development of signs consistent with withdrawal. The appropriate duration of hospital observation is variable and depends on a careful assessment of the maternal drug history. An infant born to a mother on a low-dose prescription opioid (e.g., hydrocodone, average 1,600 mg/day) may be safely discharged if there are no signs of withdrawal by 3 days of age, whereas an infant born to a mother on an opioid with a prolonged half-life (e.g., methadone) should be observed for a minimum of 5 to 7 days. Initial treatment of infants who develop early signs of withdrawal is directed at minimizing environmental stimuli (both light and sound) by placing the infant in a dark, quiet environment, avoiding stimulation by careful swaddling, responding early to an infant's signs, and adopting appropriate infant positioning and comforting techniques (e.g., rocking), and providing frequent small volumes of hyperalimentation or human milk to minimize hunger and allow for adequate growth. Caloric needs may be as high as 150 to 250 kcal/kg per day because of increased energy expenditure and cost of calories from regurgitation, vomiting, and loose stools. 104 The infant needs to be carefully observed to recognize fever, dehydration, or weight loss promptly. The goals of therapy are to ensure that the infant achieves adequate sleep and nutrition to establish a consistent pattern of weight gain and begins to migrate into a social environment. Maternal screening for comorbidities, such as HIV or hepatitis C virus infections and polysubstance abuse, needs to be performed. Additional supportive care in the form of intravenous fluids, replacement electrolytes, and gastric feedings may be necessary to stabilize the infant's condition in the acute phase and obviate the need for pharmacologic intervention. When possible, and if not otherwise contraindicated, mothers who adhere to a supervised drug treatment program should be encouraged to breastfeed as long as the infant continues to gain weight. Breastfeeding or the feeding of human milk has been associated with less severe NAS that presents later and less frequently requires pharmacologic intervention. 105,106

Methadone is present in very low concentrations in human milk. Cumulative daily intake of methadone in fully breastfed infants has been estimated to range from 0.11 to 0.15 mg/day in the first 30 days of life and 0.15 to 0.30 mg/day between 30 and 180 days of age. 107 Similarly, the amount of buprenorphine excreted in human milk is small. Although more information is needed to evaluate longer-term neurodevelopmental outcomes of infants exposed to small quantities of buprenorphine, there is no clear reason to discourage breastfeeding in mothers who adhere to methadone or buprenorphine maintenance treatment. 108

Each nursery should adopt a protocol for the evaluation and management of neonatal withdrawal, and staff should be trained in the correct use of an abstinence assessment tool in a recent survey of accredited US neonatologic fellowship programs, only 55% had implemented a written NAS protocol, and only 39% used a published abstinence scoring system. 109

RATIONAL AND COMPARATIVE EVIDENCE FOR PHARMACOLOGIC TREATMENT
Drug therapy is indicated to relieve moderate to severe signs of NAS and to prevent complications such as fever, weight loss, and seizures if an infant does not respond to a committed program of nonpharmacologic support. Since the introduction of the abstinence scoring scales in 1975, published reports have documented that the decision to initiate pharmacologic treatment has been based on single or serial withdrawal scores. However, no studies to date have compared the use of different withdrawal score thresholds for initiating pharmacologic intervention on short-term outcomes, including severity and duration of withdrawal signs, weight gain, duration of hospitalization, and need for pharmacologic treatment, or cumulative drug exposure. Withdrawal from opioids or sedative-hypnotic drugs may be life-threatening, but ultimately, drug withdrawal is a self-limited process. Inadequate pharmacologic treatment will prolong drug exposure and the duration of hospitalization to the possible detriment of maternal-infant bonding. The only clearly defined benefit of pharmacologic treatment is the short-term amelioration of clinical signs. Studies have not addressed whether long-term morbidity related to neonatal drug withdrawal is decreased by pharmacologic management of affected infants, whether continued postnatal drug exposure augments the risk of neurobehavioral and other morbidities. It is possible that pharmacologic therapy of the infant may introduce or reawaken a maternal disposition to rely on drugs for the treatment of infant discomfort or abnormal behavior. 109 Clinicians have treated NAS with a variety of drug preparations, including opioids (lactate, dipropionate, diacapram, ketobemidone, flurazepam, etc.), barbiturates (phenobarbital, pentobarbital, secobarbital, chloral hydrate, etc.), and miscellaneous (carmine). Evidence pertinent to the use of these drug preparations in infants is well summarized in the previous American Academy of Pediatrics statement. 109 Recent surveys have documented that, in accord with the recommendations of that statement, 94% of UK and 85% of US clinicians use an opioid (morphine or methadone) as the drug of first choice. The majority of practitioners use phenobarbital as a second drug or if the opiate does not adequately control withdrawal signs. 109 Daily doses of morphine range from 0.24 to 0.7 mg/kg per day, and 1.5 mg/kg per day. 109

Paragomine is no longer used, because it contains variable concentrations of other opioids, as well as toxic ingredients such as camphor, anisaldehyde, belladonna, and benzoin. 109 The use of diacapram has also fallen into disfavor because of a documented lack of efficacy compared with other agents and because of its adverse effects on infant suck and swallow reflexes. 109,110 Meta-analyses of published trials regarding the pharmacologic treatment of neonatal withdrawal are available. 111,112

In 2004, an evidence-based meta-analysis, either an opioid 113 or a sedative 114 drug treatment

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**NEONATAL ABSTINENCE SCORING SYSTEM**

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**TOTAL SCORE**

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**FIGURE 1**
Modified Finnegan's Neonatal Abstinence Scoring Tool. Adapted from ref 101.
Studies have not addressed whether long-term morbidity related to neonatal drug withdrawal is decreased by pharmacologic management of affected infants, or whether continued postnatal drug exposure augments the risk of neurobehavioral and other morbidities. It is possible that pharmacologic therapy of the infant may introduce or reenforce a maternal disposition to rely on drugs for the treatment of infant discomfort or annoying behavior.112

Clinicians have treated NAS with a variety of drug preparations, including opioids (tincture of opium, neonatal morphine solution, methadone, and paraldehyde), barbiturates (phenobarbital), benzodiazepines (diazepam, oxazepam, and lorazepam), and anticonvulsants and phenothiazines (chlorpromazine). Information pertinent to the use of these drug preparations in infants is well summarized in the previous American Academy of Pediatrics statement.113 Recent surveys have documented that, in accord with the recommendations of that statement, 94% of US and 33% of US clinicians use an opioid (morphine or methadone) as first choice. The majority of practitioners use phenobarbital as a second drug, if the opiate does not adequately control withdrawal signs.113,114 Daily doses of morphine ranged from 0.24 to 0.3 mg/kg per day. Paraldehyde is no longer used, because it contains variable concentrations of other opioids, as well as toxic ingredients such as camphor, anise oil, alcohol, and benzoic acid.115 The use of diazepam has also fallen into disfavor because of a documented lack of efficacy compared with other agents and because of its adverse effects on infant suck and swallow reflexes.116-118

Meta-analyses of published trials comparing the pharmacologic treatment of neonatal withdrawal are available.119,120 In 2 Cochrane meta-analyses, either an opioid or a sedative drug treatment was compared with a control treatment that could include a nonpharmacologic intervention, a placebo treatment, or another opioid and/or sedative drug. The authors prospectively designed 4 primary outcomes (failure of treatment to control withdrawal signs, incidence of seizures, survival, and neurodevelopmental outcome) for meta-analysis. Treatment failure was defined variably as the inability of the treatment to maintain abstinence scores within a preset “safe” level and/or the need to add another drug therapy. Some studies did not report primary outcomes and instead quantified secondary outcomes (eg, duration of treatment, duration of hospitalization, rate of weight gain, etc).

Seven studies of opioid treatment (enrolled a total of 356 infants) were identified between 1983 and 2004. Methodologic flaws were common and included randomization of patient allocation; substantial and often unexplained differences in allocation of patients to treatment groups; and unblinding. A group characteristic in studies prior to randomization was lack of concealment. Failure to mask study treatments and failure to mask outcome measurements. In the single study that assessed oral morphine treatment versus supportive therapy only, 3 consecutive Finnegan scores ≥2 prompted institution of the intervention.119 No significant effect of morphine was found on the rate of treatment failure. Oral morphine significantly increased the duration of treatment and the length of hospital stay, but it did not reduce the number of days required to regain birth weight and duration of supportive care. Four studies compared treatment failure rates of opioids (paraldehyde, oral morphine, and methadone) with phenobarbital.112,113,120 Neither the meta-analysis nor any individual study identified a significant difference in treatment failure. One study reported a lower incidence of seizures in the opioid (paraldehyde) treatment group.120 No consistent trends in secondary outcomes were observed, although 1 study reported a shorter duration of therapy in the phenobarbital group.112,113 and another found no significant differences in duration of treatment, duration of hospitalization, or in weight gain (g/day) in infants treated with either DOD or oral morphine drugs. A retrospective study found no difference in length of hospitalization in infants with NAS who were treated with methadone or oral morphine solution, but did correlate higher maternal methadone doses with longer lengths of stay.120

Bennet et al112 examined the incidence of NAS in infants born to mothers maintained on methadone, morphine, or buprenorphine and compared neurobehavioral and oral morphine treatments in affected infants. Sixty-eight percent of infants born to mothers maintained on methadone required pharmacologic treatment at a mean age of 34 hours, compared with 62% of infants, at a mean age of 51 hours in the morphine group and 21% of infants at a mean age of 54 hours in the buprenorphine group. The duration of treatment of was significantly shorter for infants who received morphine compared with infants who were treated with phenobarbital. A randomized comparison trial of buprenorphine versus lorazepam for the treatment of NAS showed a nonsignificant reduction in length of treatment and duration of hospitalization in the buprenorphine group.118 Buprenorphine therapy was also well tolerated.

Cordaine is an opioid receptor agonist that has been used in combination with an opioid or other drug in patients with severe withdrawal symptoms.119,121 It is used for a negative feedback mechanism, cordaine...
A recently published case series from France that used a historical cohort for a comparison has suggested that the treatment of NAS with the pheno- thiazine chlorpromazine, as a single drug, may be more effective than treatment with morphine. Infants treated with chlorpromazine had significantly longer median durations of treatment and hospitalization in comparison with infants treated with morphine. No adverse effects were reported.

OUTCOME

Assessment of potential long-term morbidity specifically attributable to neonatal drug withdrawal and its treatment is difficult to evaluate. Few studies have followed drug-exposed children beyond the first few years of life. Confounding variables, such as environment and dysfunctional caregivers, complicates the interpretation of outcomes. In a small study, developmental scores on the mental index on the Bayley Scales of Infant Development were not affected by the severity of withdrawal or the treatment chosen. Mean scores on the Bayley Scales of Infant Development were similar for all infants treated for withdrawal, including those receiving phenoobarbital, pentobarbital, or a combination therapy. Scores of infants whose withdrawal was too mild to qualify for pharmacologic intervention were also similar.

Fourteen drug-exposed infants with withdrawal-associated seizures were reported by Dobrozak et al. The absence scores for 5 of these infants were <7 (the cutoff for treatment), hence, they received no pharmacologic therapy before the onset of seizures. Thirteen of the 14 infants were offspring of mothers enrolled in a methadone treatment program; however, the success of maternal treatment was not described. Of the 14 infants with seizures, 12 were available for evaluation at 1 year of age; results of neurologic examinations were normal in 9 of the 12 infants evaluated. EEG results were abnormal in 8 neonates; however, subsequent EEGs for 7 of 8 of these infants normalized during follow-up. Mean scores on the Bayley Scales of Infant Development were also normal by 1 year of age, similar to matched controls that were drug exposed, but in whom withdrawal-associated seizures did not develop. Withdrawal-associated seizures seem to be primarily myoclonic, to respond to opiates, and to carry no increased risk of poor outcome. Withdrawal-associated seizures in neonates are different from those associated with other causes. Based on the depression of nonspecific thalamic and dopamine output observed with methadone exposure in animal models, withdrawal seizures are speculated to be attributable to lowered levels of neurotransmitters.

The normalization of the EEG and normal neurologic development are believed to reflect recovery of normal neurotransmitter concentrations during early infancy. Bardstra et al. have comprehensively reviewed outcomes of infants and toddlers who were exposed prenatally to opioids and cocaine.

MANAGEMENT OF ACQUIRED OPIOID AND BENZODIAZEPINE DEPENDENCY

One of the cornerstones in caring for critically ill children is to provide adequate and safe analgesia, sedation, amnesia, and anxiolysis using both pharmacologic and nonpharmacologic measures. Pharmacologic treatment typically includes medications in the opioid and benzodiazepine drug classes. However, if these drugs cannot safely be discontinued within a few days, physical dependence on 1 or both of these classes of medication can develop and manifest with signs of withdrawal on acute dosing reduction or cessation of therapy. Infants who undergo complex surgical procedures may require prolonged medical intensive care for conditions such as respiratory failure or persistent pulmonary hypertension. In adults, opiate withdrawal is managed with benzodiazepine or psychopharmacologic agents or propofol for 24 hours. Signs and symptoms of withdrawal from fentanyl commenced 24 hours of cessation of therapy.

The reliance of pain management in children over the past 2 decades has witnessed an expansion of the use of opioids in the intensive care setting. As a result, more children have been treated for actual or potential withdrawal symptoms as a comorbidity of hospitalization. Fentanyl, a pure μ-opioid receptor antagonist, has become the opioid of choice because of its rapid onset of action, short duration of effect (half-life of 0.5–1 hour), excellent potency, and minimal adverse effects. However, fentanyl has not been demonstrated to be safer or more effective than morphine for the provision of long-term analgesia. Indeed, this study has reported that patients who were treated prospectively with a continuous morphine infusion during ECMO experienced a significantly lower need for supplemental analgesia, a lower rate of dependency, and a shorter hospital stay compared with a previous group of patients treated with fentanyl during ECMO.

ECMO patients have employed a variety of strategies to treat or, in high-risk patients, to prevent signs and symptoms of opioid withdrawal in infants and children. Carr and Todurski reported success with a gradual taper of the opioid infusion rate. Children who had received continuous opioid infusions for more than a week required 2 to 3 weeks for complete weaning. One disadvantage of this approach was that intravenous access had to be maintained for the entire course of treatment. Tobias et al. were among the first investigators to describe treatment of opioid withdrawal by conversion to enteral methadone. In adults, weaning was begun as the opioid of choice because of its excellent oral bioavailability (70%–100%) and long half-life (19–41 hours), which allowed for long intervals between doses. In this initial report, 3 symptomatic patients who had been exposed to continuous or bolus opioids for up to 7 weeks transitioned to a methadone regimen of 0.1 mg/kg, orally, every 12 hours. Dose reduction by 10% to 20% of the initial dose per week resulted in successful weaning in 4 to 6 weeks.

In 2000, Robertson and et al. described the occurrence of 16 children 6 months to 18 years of age who had received >7 days of opioids (range: 7–53 days). An amount of methadone, equivalent to the existing daily fentanyl or morphine dose, was determined. This amount was reduced by a factor of 8 because of the longer half-life of methadone to calculate the initial total daily methadone dose. Protocols specified 2 different weaning schedules, depending on whether the patient had been treated with opioids (fentanyl or morphine) for either 7 to 14 days or for >14 days. Treatment intervals were gradually lengthened from every 6 hours to every 24 hours when methadone was discontinued. Outcomes of these patients were compared with recent control patients who had also been treated with enteral methadone but not under a standard protocol. Among the protocol patients, there were no treatment failures. Weaning was accomplished in a mean of 8 days (range: 5–10 days), which was significantly less than the median of 20 days (range: 9–31 days) observed in the nonprotocol patients. Concomitant use of benzodiazepines occurred in 8 of the protocol children, compared...
Percent of NAS Patients Treated with Morphine

Year

2003 2004 2005 2006 2007 2008 2009 2010

% Treated with Morphine

0.0% 10.0% 20.0% 30.0% 40.0% 50.0% 60.0% 70.0% 80.0% 90.0% 100.0%
Length of Stay: Methadone exposed infants

Mean = 22.5
The standard approach: why?

- Medications
Source: Grossman Family Album

Intervention 1

Focus on non-pharmacologic care
Length of Stay: Methadone exposed infants

Mean = 22.5

Mean = 13.2
The standard approach: why?

- Medications
- NICU
Intervention 2

Direct transfer to the general inpatient unit
Length of Stay: Methadone exposed infants

- **ADMIT DATE:**
  - 1/30/08 to 12/26/11
  - 2/4/12 to 5/6/14

- **LENGTH OF STAY (Days):**
  - Mean of 10.2 days
  - Mean of 22.5 days
  - Mean of 13.2 days

- **Graph Details:**
  - UCL = 32.5
  - CL = 10.2
  - LCL = 0.0

- **Legend:**
  - Standardized non-pharm care
  - Direct transfer to inpatient unit
The standard approach: why?

- Medications
- NICU
- Finnegan Scores
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<th>SIGNS AND SYMPTOMS</th>
<th>SCORE</th>
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<th>2</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
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<tr>
<th>SUMMARY</th>
<th>TOTAL SCORE</th>
<th>SCORER'S INITIALS</th>
<th>STATUS OF THERAPY</th>
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</table>

“The infant with a score of “7” or less was not treated with drugs for the abstinence syndrome because, in our experience, he would recover rapidly with swaddling and demand feedings. Infants whose score was “8” or above were treated pharmacologically”
Problems with the Finnegan

- Long lengths of stay and lots of meds
- Purpose of treatment is to get the scores below threshold
- Must disturb the infant and exacerbate signs of withdrawal
- Can be slow to respond
- Powerful and potentially harmful meds to give to treat a sneeze or a yawn
Intervention 3

Discontinuation of the Finnegan Scoring tool and adoption of a functional scoring approach
1) Can the baby eat?
2) Can the baby sleep?
3) Can the baby be consoled?
ESC Study

- Analyzed 50 consecutive NAS babies admitted to our general inpatient unit from March 2014 to August 2015

- Assessed every 2-6 hours using the FNASS, but did not guide management

- Management decisions based on ESC
Outcomes

1. Proportion of infants treated with morphine vs. proportion predicted to be treated with morphine using the FNASS approach

2. Days the two approaches disagreed

3. FNASS scores the day after the two approaches disagreed
Results

Proportion of Infants that Received Morphine

- Received Morphine (ESC): 12%
- Would Have Received Morphine (Finnegan): 62%

p < .001

NAS infants (n=50)
## Results by Hospital Day

<table>
<thead>
<tr>
<th>Hospital Days (n=296):</th>
<th>ESC Approach</th>
<th>FNASS Approach Predicted</th>
<th>P value</th>
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<td>Increased Morphine</td>
<td>8 (2.7%)</td>
<td>76 (26%)</td>
<td>&lt;0.01</td>
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<td>No Morphine</td>
<td>258 (87.2%)</td>
<td>156 (52.7%)</td>
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<tr>
<td>Decreased Morphine</td>
<td>21 (7.1%)</td>
<td>35 (11.8%)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Same Morphine</td>
<td>9 (3%)</td>
<td>29 (9.8%)</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>
Results

- On 78 days (26.4%) the ESC Led to LESS Morphine than Predicted by The Finnegan
  - The following day, the average Finnegan score decreased by 0.9 points, and decreased in 69% of cases.

- On 2 days (0.7%) the ESC Led to MORE Morphine than Predicted by The Finnegan
  - In both cases the average Finnegan score increased by 1.7 Points the next day
Results

- No readmissions
- No seizures
- No ICU transfers
“Withdrawal from opioids or sedative-hypnotic drugs may be life-threatening, but ultimately, drug withdrawal is a self-limited process. Unnecessary pharmacologic treatment will prolong drug exposure and the duration of hospitalization to the possible detriment of maternal-infant bonding. The only clear benefit of pharmacologic treatment is the short-term amelioration of clinical signs.”

The standard approach: why?

- Medications
- NICU
- Finnegan Scores
- Medication Dosing
Intervention 5

Decrease in morphine up to 3 times per day
Intervention 6

PRN Dosing
Length of Stay: Methadone exposed infants

- Direct transfer to inpatient unit
- Standardized non-pharm care
- Novel assessment tool on inpatient unit
- Spread to NICU team
- Prenatal counseling
- Rapid med weaning

LENGTH OF STAY (Days)

- Mean=22.5
- Mean=13.2
- Mean=10.2
- Mean=7.7

ADMIT DATE
The standard approach: why?

- Medications
- NICU
- Finnegan Scores
- Medication Dosing
- Staff cares for the baby
How do moms feel?

- Addiction is misunderstood
- Guilty
- Judged
- Mistrusting of nurses
“I would just tell (the nurses) to take it easy (on the mother). You know, after being addicted, I realized that this is really a disease. There are some who abuse, but if you’re using while you’re pregnant, you have a problem; a big problem...and you need help”
“His nurse was like ‘his muscles are locking up because of his junkie mom’. I didn’t want to visit, I would call before and if that nurse was there, I wouldn’t even go.
“...because we’re gonna leave and he’s gonna cry and they’re gonna leave him crying because they’re gonna be like, ‘you know what? His parents are jerks!’”
Intervention 7

Empowering messaging
Old Protocol

- Goal: suppress withdrawal signs
- NICU: Mom visits
- Finnegan Scores: treat the number
- “supportive care”
- “feed on demand”
- Morphine
- Surprise!
- Staff takes care of infant

New Protocol

- Goal: have infant function as a normal neonate
- Mother and child together
- Eat/Sleep/Console: treat the infant
- SUPPORTIVE CARE
- No feeding schedule
- Meds on page 3
- Prenatal preparation
- Staff coaches parents
Length of Stay: Methadone exposed infants

- Standardized non-pharm care
- Direct transfer to inpatient unit
- Novel assessment tool on inpatient unit
- Spread to NICU team
- Prenatal counseling
- Rapid med weaning
- Meds as needed
- Empowering messaging

Length of Stay: Methadone exposed infants

Mean=22.5
Mean=13.2
Mean=10.2
Mean=7.7
Mean=5.9

Admit Date

0.9
10.8
20.0
30.0
40.0
50.0
60.0
70.0

Length of Stay (Days)
Average Length of Stay - Methadone Exposed Infants

- **Protocol Change:** More aggressive weans
- **Discontinued Finnegan Scoring**
- **Focus on supportive management**
- **Transfers directly from WBN to Floor**
- **NICU included in effort**
- **More aggressive weans**
Percent of NAS Patients Treated with Morphine

- Year: 2003 to 2015
- % Treated with Morphine: 0.0% to 100.0%

The graph shows the percentage of NAS patients treated with morphine from 2003 to 2015, with the percentage ranging from 0.0% to 100.0%. The data indicates a trend of consistent treatment levels during this period.
Percent Treated with Morphine

Date

Percent Treated

Percent of NAS Patients Treated with Morphine

- NICU: Constant treatment from 2008 to 2016
- non-NICU: Decreasing trend from 2008 to 2016
Average Length of Stay - Methadone Exposed Infants
Average Maximum Morphine Dose

Average maximum morphine dose (mg/dose)

Year

Average maximum morphine dose (mg/dose)

Year

p < .001
Breastfeeding Rate

% Breastfeeding vs. Year

- 2003: Start of data collection
- 2004: Initial rise in breastfeeding rate
- 2005: Steady increase
- 2006: Minor decline
- 2007: Further increase
- 2008: Major rise
- 2009: Peak
- 2010: Minor decline
- 2011: Recovery
- 2012: Slight drop
- 2013: Significant growth
- 2014: Steady increase
- 2015: Continued rise
- 2016: Highest rate recorded

% Breastfeeding over the years shows a trend of increasing rates, with fluctuations in some years.
Total Average Cost of NAS Care

- Year: 2003 to 2015
- Total Cost ($): 0 to 60000
- p < .001

- Graph shows a trend of decreasing total average cost of NAS care over the years, with a significant decrease after 2008.
Cycle 1: May 2016
- Staff education
- Prenatal messaging
- Non-pharm care bundle
- Finnegan symptom prioritization

Cycle 2: July 2016
- Methadone
- No Tx in the first 24 hours

Cycle 3: Dec 2016
- Eat, Sleep, Console (ESC)
- Cuddlers
<table>
<thead>
<tr>
<th>Central Nervous System Disturbances</th>
<th>Metabolic, Vasomotor, and Respiratory Disturbance</th>
<th>Gastrointestinal Disturbance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excessive High Pitched Crying – 2 Continuous High Pitched Crying - 3</td>
<td>Sweating – 1</td>
<td>Excessive Sucking – 1</td>
</tr>
<tr>
<td><strong>Sleep &lt; 1 Hr After Feeding – 3</strong>&lt;br&gt;Sleep &lt; 2 Hr After Feeding – 2&lt;br&gt;Sleep &lt; 3 Hr After Feeding – 1</td>
<td>Fever &lt; 101 (37.2 – 38.3 C) – 1&lt;br&gt;Fever &gt; 101 (38.4 C) – 2</td>
<td>Poor feeding – 2</td>
</tr>
<tr>
<td>Hyperactive Moro Reflex – 2&lt;br&gt;Markedly Hyperactive Moro – 3</td>
<td>Frequent Yawning (&gt;3) – 1</td>
<td>Regurgitation – 2&lt;br&gt;Projective Vomiting – 3</td>
</tr>
<tr>
<td>Mild Tremors Disturbed – 1&lt;br&gt;Mod – Sev Tremors Disturbed – 2</td>
<td>Mottling – 1</td>
<td>Loose Stools – 2&lt;br&gt;Watery Stools – 3</td>
</tr>
<tr>
<td>Mild Tremors Undisturbed – 3&lt;br&gt;Mod – Sev Tremors Undisturbed - 4</td>
<td>Nasal Stuffiness – 1</td>
<td></td>
</tr>
<tr>
<td>Increased Muscle Tone - 2</td>
<td>Sneezing (&gt;3) – 1</td>
<td></td>
</tr>
<tr>
<td>Excoriation – 1</td>
<td>Nasal Flaring – 2</td>
<td></td>
</tr>
<tr>
<td>Myoclonic Jerk – 3</td>
<td>Respiratory Rate (&gt;60) – 1&lt;br&gt;Respiratory Rate (&gt;60 Retractions) – 2</td>
<td></td>
</tr>
<tr>
<td>Seizures – 5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Eating
Poor feeding due to NAS

Sleeping
<1 hr after feeding due to NAS

Consolability
Infant’s consolability rating
Unable to console within 10 minutes
Caregiver(s) providing the consolability

Parental Presence
Parental presence since last assessment

Cuddler Present
Cuddler present

Team Huddle
Team huddle

Row Information
Adequate feeding depends on the GA and postnatal age of the infant. Poor eating due to NAS is defined as the baby being unable to coordinate feeding within 10 minutes of showing hunger AND/OR unable to sustain feeding for 10-15 minutes at breast or 10-15 cc of bottle feeding due to NAS symptoms.

Do not indicate “YES” for poor eating if this is clearly due to non-NAS related factors such as prematurity, transitional sleepiness or spittiness in the first 24 hours life, or inability to latch due to maternal or infant anatomical factors. If it is not clear if the poor eating is due to NAS, please indicate “YES” and continue to monitor closely.
**ESC EPIC Flowsheet**

### Early Feeding
- **Eating**
  - Poor feeding due to NAS

### Early Sleeping
- **Sleeping**
  - <1 hr after feeding due to NAS

### Consolability
- **Consolability**
  - Infant’s consolability rating
  - Unable to console within 10 minutes
  - Caregiver(s) providing the consolability

### Parental Presence
- **Parental Presence**
  - Parental presence since last assessment

### Cuddler Present
- **Cuddler Present**
  - Cuddler present

### Team Huddle
- **Team Huddle**
  - Team huddle

---

### Instructions
- **Row Information**
  - Normal sleep patterns for GA and postnatal age should be taken into account. Sleep < 1 hour may be normal in the first few days after birth.
  - Indicate "YES" for sleep < 1 hour due to NAS if the baby is unable to sleep for more than 1 hour due to NAS symptoms.
  - Do not indicate "YES" if this is clearly due to non-NAS related factors such as physiologic cluster feeding, and interruptions in sleep for routine newborn testing.
  - If it is unclear if the poor sleep is due to NAS, please indicate "YES" and continue to monitor the infant closely.
Percent of infants pharmacologically treated

- Mean 86%
- Mean 44%

- Non-Pharm Care Bundle
- Symptom prioritization
- Prenatal education

Staff QI education
ESC Care Tool
Cuddlers
Methadone

Month of admission

Percent treated
UCL
LCL
Percent of infants % Treated Average - - - UCL and LCL
Pharmacologically treated infants who received adjunctive medication

- Mean 34%
- Mean 0%

Non-Pharm Care Bundle
- Symptom prioritization
- Prenatal education

Methadone

ESC Care Tool
- Cuddlers

Staff QI education
Length of hospital stay for all opioid-exposed infants

- **Mean**: 18.4 days
- **UCL**: 40 days
- **LCL**: 0 days

- **Mean LOS**: 10.4 days

- **Measures**:
  - Non-Pharm Care Bundle
  - Symptom prioritization
  - Prenatal education

- **Interventions**:
  - ESC Care Tool
  - Cuddler
  - Staff QI Education
  - Methadone

- **Hospital days**

- **Month of admission**
  - Jan 2014
  - Feb 2014
  - March 2014
  - April 2014
  - May 2014
  - June 2014
  - July 2014
  - Aug 2014
  - Sept 2014
  - Oct 2014
  - Nov 2014
  - Dec 2014
  - Jan 2015
  - Feb 2015
  - March 2015
  - April 2015
  - May 2015
  - June 2015
  - July 2015
  - Aug 2015
  - Sept 2015
  - Oct 2015
  - Nov 2015
  - Dec 2015
  - Jan 2016
  - Feb 2016
  - March 2016
  - April 2016
  - May 2016
  - June 2016
  - July 2016
  - Aug 2016
  - Sept 2016
  - Oct 2016
  - Nov 2016
  - Dec 2016
  - Jan 2017
  - Feb 2017
  - March 2017
Percent Parental Presence

Measure

Mean 80%

Mean 50%
# New ESC Tool

## TIME

### EATING

<table>
<thead>
<tr>
<th>Poor eating due to NAS? Yes / No</th>
</tr>
</thead>
</table>

### SLEEPING

<table>
<thead>
<tr>
<th>Sleep &lt; 1 hr due to NAS? Yes / No</th>
</tr>
</thead>
</table>

### CONSOLING

<table>
<thead>
<tr>
<th>Unable to console within 10 min due to NAS? Yes / No</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Soothing support used to console infant:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soothes with little support: 1</td>
</tr>
<tr>
<td>Soothes with some support: 2</td>
</tr>
<tr>
<td>Soothes with great support: 3</td>
</tr>
</tbody>
</table>

### PARENTAL PRESENCE

<table>
<thead>
<tr>
<th>Parental presence since last assessment:</th>
</tr>
</thead>
<tbody>
<tr>
<td>No parent present 0</td>
</tr>
<tr>
<td>1 - 59 minutes: 1</td>
</tr>
<tr>
<td>1 hr - 1 hr 59 min: 2</td>
</tr>
<tr>
<td>2 hr - 2 hr 59 min: 3</td>
</tr>
<tr>
<td>3 hr+: 4</td>
</tr>
</tbody>
</table>

### HUDDLE

<table>
<thead>
<tr>
<th>Team Huddle called? Yes / No</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Team Huddle treatment decision:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimize non-pharm care further: 1</td>
</tr>
<tr>
<td>Initiate medication treatment: 2</td>
</tr>
</tbody>
</table>

### NON-PHARM CARE INTERVENTIONS

<table>
<thead>
<tr>
<th>Rooming in: Increased / Reinforced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parental presence: Increased / Reinforced</td>
</tr>
<tr>
<td>Skin-to-skin contact: Increased / Reinforced</td>
</tr>
<tr>
<td>Holding by caregiver/cuddler: Increased / Reinforced</td>
</tr>
<tr>
<td>Swaddling: Increased / Reinforced</td>
</tr>
<tr>
<td>Optimal feeding quality: Increased / Reinforced</td>
</tr>
<tr>
<td>Quiet environment: Increased / Reinforced</td>
</tr>
<tr>
<td>Limit visitors: Increased / Reinforced</td>
</tr>
<tr>
<td>Optional Comments:</td>
</tr>
</tbody>
</table>

---

## DEFINITIONS

### EATING

- Poor eating due to NAS: Baby unable to coordinate feeding within 10 minutes of showing hunger AND/OR unable to sustain feeding for 10-15 minutes at breast or with 15-30 cc of finger- or bottle-feeding due to NAS symptoms (e.g. fussiness, tremors, uncoordinated or excessive suck).
- Special Note: Do not indicate “Yes” for poor eating if it is clearly due to non-NAS related factors (e.g., prematurity, transitional sleep issues or spitting in the first 24 hours of life, inability to latch due to malalignment or other infant anatomical factors). If it is not clear if the poor eating is due to NAS, please indicate “Yes” on the flow sheet and continue to monitor the infant closely.

### SLEEPING

- Sleep < 1 hr due to NAS: Baby unable to sleep for more than one hour stretch after feeding due to NAS symptoms (e.g. fussiness, restlessness, increased startle, tremors)
- Special Note: Do not indicate “Yes” if sleep < 1 hour is clearly due to non-NAS related factors (e.g., physiologic cluster feeding, interruptions in sleep for routine newborn testing). If it is not clear if sleep < 1 hour is due to NAS, please indicate “Yes” on the flow sheet and continue to monitor the infant closely.

### CONSOLING

- Unable to console within 10 minutes due to NAS: Baby unable to be comforted within 10 minutes by infant caregiver effectively providing recommended Counseling Support interventions
- Special Note: Do not indicate “Yes” if infant’s insusceptibility is due to infant hunger, difficulty feeding or other non-NAS source of discomfort (e.g., circumcision pain). If it is not clear if the inability to console within 10 minutes is due to NAS, please indicate “Yes” and continue to monitor the infant closely.

### Counseling Support Interventions (CSIs)

- Caregiver begins talking to infant and uses higher voice to calm infant
- Caregiver continues talking to infant and places hand on infant’s abdomen
- Caregiver continues talking to infant and holds infant’s arms and legs toward center
- Picks up infant, holds skin-to-skin or swaddled in blanket, and gently rocks or sway infant
- Offers a finger or pacifier for infant to suck, or a feeding if infant showing hunger cues

### SOOTHING SUPPORT USED TO CONSOLE INFANT

1. **Soothes with little support:** Consistently self-soothes or is easily soothed (i.e., with one of first 3 CSIs above)
2. **Soothes with some support:** Soothes with skin-to-skin contact, being held, swaddled, rocked or swaying, or finger or pacifier for feeding
3. **Soothes with much support:** Has difficulty responding to all support efforts listed above; never self-soothes

### PARENTAL PRESENCE

- Time since last assessment that biological parent or foster parent has spent in room with infant

### OPTIMAL FEEDING QUALITY:

- Baby feeding at early feeding cues until content without any limit placed on duration or volume of feeding
- Breastfeeding: Baby latching deeply with comfortable latch for mother, and sustained active sucking for baby with only brief pauses noted. Assist directly with breastfeeding to achieve more optimal latch/position and request lactation consultation if any concerns present.
- Bottle feeding: Baby effectively coordinating suck and swallow without gagging or excessive spitting up; modify position of bottle or flow of nipple if any concerns present.
Additional Spread
Conclusions

- Hugs before drugs
  - Empower families
  - Rooming-in
  - Non-Pharmacologic care as 1st line treatment
  - ESC approach
  - PRN meds
- Ask why
Acknowledgements

- David Hersh, MD
- Adam Berkwitt, MD
- Erin Nozet, MD
- Marcelle Applewaite, RN
- Kim Carter, RN
- Liz O’Mara
- Matt Bizzarro, MD
- Yogangi Malhotra, MD
- Jonathan Miller, MD
- Camisha Taylor, RN
- Rachel Osborn, MD